DOCUMENT RESUME

ED 220 265 SE 038 250

AUTHOR	Mowery, Donald R.; Wolf, Lawrence J.
TITLE	Science and Engineering Technician Curriculum Development Project. Final Report.
INSTITUTION	Saint Louis Community Coll. at Florissant Valley, Mo.
SPONS AGENCY	National Science Foundation, Washington, D.C.
PUB DATE	79
GRANT	GZ-3378; HES-74-22284; SED-77-17935
NOTE	64p.
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	*College Science; *Curriculum Development; Curriculum Evaluation; *Engineering; *Engineering Education; Higher Education; Physical Sciences; Program Evaluation; Science Curriculum; Science Education; *Study Guides; *Technical Education; Technical Mathematics
IDENTIFIERS	Science Education Research

ABSTRACT

Project SET (Science and Engineering for Technicians) developed a series of study guides designed to teach generic science and engineering skills to students interested in becoming technicians. An entire 2-year curriculum is encompassed by these guides, geared for 2-year college students. Described in this final report are the project's rationale, goals, and activities (curriculum design and trial implementation), study guide production, dissemination activities, and evaluation activities. Appendices include Advisory Committee list, Cooperating Colleges list, SET Study Guide Contents, and Summary Evaluation Findings/Recommendations by Karen C. Cohen. Topics of study guide lists include algebraic/trigonometric equations; analog/digital electronics; chemical science/technology; computer/calculator techniques; calculus; electronic components, transducers, and basic circuits; functions, analytic geometry, and statistics; electronic instrumentation; materials/fabrication methods; writing organization/expression; physics of electromagnetic optical and solid state systems; physics of mechanical gaseous/fluid systems; and science/engineering graphics. Instruments used and complete results of pre- and post-surveys of teachers and students are provided in the summary evaluation appendix. Results indicate that although the study guides were well received there was no indication that they can be used in self-study or stand-alone fashion. (Author/JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED220265

SED77-17935

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
✓ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

SCIENCE AND ENGINEERING TECHNICIAN CURRICULUM DEVELOPMENT PROJECT

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Pat Bell
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

FINAL REPORT

SE038250

Science and Engineering Technician Curriculum Development Project

FINAL REPORT

Funded by
National Science Foundation
Grant Numbers SED77-17935, HES74-22284, and GZ-3378

Submitted by
Donald R. Mowery
and
Lawrence J. Wolf

I. Need for the Science and Engineering Technology Curriculum

"As technology changes, engineering technology programs are established to provide the needed technician. The delay between the emergence of a new area and a needs survey may be two or three years. The development and implementation of a curriculum to meet the needs requires another year or two. If accreditation requirements are to be met, still more time may be required. By the time technicians are prepared in a specialty, it has been changed by advances in technology, or there are new more severe needs for technicians."

This paragraph from the original proposal dated May 10, 1974 for a General Engineering Technician Curriculum is a concise statement of need for the project which was begun in July 1974 and continued through to May 1979. The first three years of the project were supported by the NSF on grant #SED 74-22284 until 1977 and then on grant #SED 77-17935 until May 1979. The title of the grants were "Development of a General Engineering Technician Curriculum".

Herein the word "Project" will be used to refer to the project suggested by the two grants in series. The Project came to be called the Science and Engineering Technician Curriculum Project by those persons who worked on it over its five year time span.

The need as stated in that program from the original proposal has not changed over the years the project has been in operation. In fact, the need has become more severe due to societal pressures in the areas of energy and environment and the rapid development of microelectronics and "smart machines" during the project tenure 1974 through 1979.

To explore the need in more detail it is necessary to recognize that an engineering technology curriculum has three components:

1. The technical specialty courses, emphasizing one specialized area.
2. The basic science and mathematics courses which support the curriculum.
3. General education in communications, social sciences and humanities.

Although the curricula are designed to provide employment at the end of two years, some four year colleges and universities accept these programs in transfer for continuation of 4-year technology or engineering degrees.

The technical specialty courses in conventional engineering technology programs are usually designed to greatly emphasize specialization in one area: electronics, mechanical, civil, chemical etc. Although efforts have been made to combine specialities (electro-mechanical technology), existing curricula do not adequately prepare technicians to adapt to great technological advances or to drastic shifts in technician requirements. Although traditional specialties in engineering technology may meet the needs of many employers for technicians and persons educated in a quality program in a specialty can make shifts within the sub-fields of that specialty, the proliferation of specialties in engineering technology never quite catches up with the needs of employers. Furthermore, studies have shown that very few technicians are actually working in the specialty for which they were educated. For these reasons there is a need for an engineering technician more generally educated in the technical specialties.

Traditional engineering technology curricula generally depend upon service departments for general education, communication skills and basic science and mathematics. These service departments are often unaware of the needs of technicians or of how such students best learn. In many areas, physics, math, and english courses are essentially the same as those taken by engineering students or liberal arts students. A general engineering technician curriculum with a more diverse offering in the technical specialties, will need greater cohesion in the service areas of science. For this reason a greater involvement of science and science teachers was anticipated. Indeed as the project unfolded there was great interest from science faculty. It became evident that in the case of the general engineering technician science courses would become technical specialty courses. For several reasons, this being an important one among them, the curriculum name was changed to Science and Engineering Technology (SET).

Another need which concerned those involved in the Project and was expressed at the outset in the fact that it is impossible for a college or university to keep up with the state of the art in equipment. Even institutions with generous support require long lead times for equipment acquisition. Skills learned on outdated apparatus and instruction have little value. In the last five years the evaluation of equipment has progressed at a rate greater than probably anytime in the history of technology. Technicians need a stronger understanding of science and math in order to keep up with the changes in equipment. Although, colleges and universities should not give up in their efforts to keep their equipment up to date, there needs to be ways to give students exposure to new equipment outside of the institutional environment.

From the foregoing, a general technician curriculum is needed having the following characteristics:

1. The curriculum requires a strong basic core of science and mathematics.

2. The science and math core must provide for understanding of the scientific principles underlying existing and yet to be developed instrumentation and apparatus used by scientists and engineers.

3. Skills and knowledge concerning specific techniques and instrumentation or apparatus in our present technology must be taught as the technical specialty.

4. The scientific, engineering, and math background of the general technician graduate must enable him to adapt quickly to changes in his job responsibilities or to changes in the technology.

5. The curriculum must prepare the student for employment at the end of two years, and this employment should have the potential of serving the graduate as a career.

6. The courses of the curriculum shold be acceptable in transfer to a four year college or university, either in a science, a technology, or engineering, so that the graduate of the two year program has the option of continuing to upgrade himself.

II. The Goals of the Original Project (1974-1977)

The goals stated for the Project are the following:

1. To design and produce a curriculum for preparation of <u>general engineering technicians</u> in a two year associate degree program.

2. To provide a trial implementation of the curriculum in selected trial schools to get feedback for revision of the curriculum and of course materials.

3. To design a model general engineering curriculum which will prepare persons, in two years, to serve as technicians in almost any technician specialty, and who have a strong enough scientific background to adapt to changes in technology.

Originally, it was conceived that the curriculum design part of the project would require one year and that the trial implementation would require two years for completion. Hence, a three year project was proposed. It turned out that indeed most curriculum design was completed in the first year. The curriculum name was decided and the courses and most course outlines were agreed upon. But many of the details of the curriculum had yet to be specified after the first year of operation.

It was decided that the content of the individual courses could best be conveyed by study guides. Study guides are considerably more than course outlines in that they include in brief form the ideas and theory to be learned. Problems and sample solutions are also contained in the study guides. Yet the study guides are not intended to replace textbooks or laboratory manuals. Recognizing that many of the SET courses were new arrangements and collections of existing material, textbooks suitable for these courses often did not exist. In these cases the study guides provides a framework for augmenting a textbook, deleting topics from the textbook or obtaining supplementary textbooks. Consequently, the study guides were too extensive to be prepared in the first year of the project. Furthermore, rather than rush them to completion it was best to gain information from the trial implementation for feedback into the study guide. The study guides were developed rather than written. In only two cases was an SET course taught for the first time without a draft from a study guide being available. Conversely in no case was a study guide left unreviewed and unmodified after being used in the classroom. The lengthy, but effective, process of study guide development required in some instances more than three years.

Not only did curriculum development extend longer than the one year originally anticipated, but the trial implementation took more than the two years alloted. It immediately became apparent that the colleges planning to enroll students in the Fall of 1975 had to be heavily involved in implementation activity during the initial year of the project. Curriculum development and curriculum trials could not be done serially, much of both activities had to be done in parallel.

Some of the trial colleges, indeed, some that now have the strongest SET curricula just couldn't bring the program up through the approval channels at their institutions in time for a Fall 1975 start up. Therefore, these schools began in the Fall of 1976 and some in the Fall of 1977. The Project was ambitious in its dissemination plans and took seriously its charge to be a project of national rather than local or regional impact. Many colleges and universities finally had to become involved in the project in order to finally have trial implementation on a national scale.

In the process of the first year, which was intensive in curriculum development, and the second and third year, which were implementation intensive, very little formal evaluation was able to take place. Therefore, by the end of the first three years of activity the project had several study guides completed, some in stages of incompletion and some not even started. Also, the project had gained an enormous amount of trial implementation experience which had more to be assimulated. Graduates had been produced but they had just entered the job market and had no experience in employment that could be evaluated. For these reasons a proposal to continue the project for another year was prepared.

III. Goals of Renewal Project

The goals of the continuance project were:

1. To finish the production of the science and engineering technician curriculum materials. (Study guides)

2. To continue the curriculum trials in order to achieve permanence and obtain further feedback.

3. To determine how well the program has prepared students for new technician jobs or for transfer to a four year college or university.

4. To lay the foundation for continuance of the Science and Engineering Technology Program after the project had terminated.

Negotiations with the National Science Foundation and the project office resulted in an increased emphasis on goals one and three (above) and a decreased emphasis on two and four. It was agreed that the project had to concentrate on the printed matter, the study guides as the means of conveying the curriculum. The project had already a large amount of implementation experience, it was now necessary to evaluate and document that experience. This could best be done in the form of a curriculum guide to help new schools establish an SET curriculum.

It was further agreed that now that graduates were in their first year of employment or transfer education, the evaluation of the project could be profitably emphasized. These evaluation results could also be emphasized in the curriculum guide.

IV. Project Activities

1. Curriculum Design

Most of the curriculum design work was done in large group meetings by representatives from the trial colleges and by a national advisory committee.

These meetings were intensive 2 day workshops which were structured and well attended by the participants. The role of the project staff was to plan the meeting for maximum group involvement and to reduce the results after the meetings. By having both employers and educators present at the sessions. The project was able to reduce to zero the time it normally takes for employers to respond to curriculum inquiries. (See Appendices I and II for the names of the advisory committee members, the cooperative colleges and the curriculum coordinator).

1.1 First National Project Meeting September 27, 28, 1974

Representatives of twelve cooperative colleges were identified. These individuals met in a concentrated session in St. Louis during which the necessary technician competencies were defined. Ways of achieving the practicum experience were discussed. Technical specialty courses were identified.

1.2 Second National Project Meeting, November 15, 19, 1974

A National Advisory Committee was appointed and in attendance at the meeting along with the college representative. High school counselors and potential employers were identified by the cooperating colleges for survey work to be performed. A general technician curriculum was proposed by each cooperating college.

1.3 The project director visited all cooperating colleges March 1-5, 1975.

1.4 Third National Project Meeting

The publicity and recruitment techniques were discussed. The study guides were planned. Course description and outlines were received. The curriculum was named Science and Engineering Technology.

1.5 A brochure describing the SET curriculum was produced and released. March 10, 1978.

1.6 During the summer of 1975 the first draft of five study guides were produced for use at the cooperating colleges.

1.7 The Fourth National Project Meeting was conducted September 26, 27, 1975 during which the second year of the program was approved and second semester course outlines were finalized.

1.8 An employer survey was conducted in each of the areas of the cooperating colleges

1.9 All parts of the curriculum had been defined by the summer of 1976, except those courses in the rapidly emerging areas of electronics. Due to the rapid developments in the area there were many ambiquities that the larger project group had difficulty clarifying. For this reason a team of eight educationa and industrial experts in electronics, all of whom had some experience with the SET project, was assembled for a meeting August 27, 28 during which the three electronics courses were finalized into course outlines.

2. Trial Implementation

Much of the project activity at and after the September 1975 project meeting had to do with the trial implementation of the curriculum. Of the eleven original group of cooperating colleges eight conducted some level of implementation in the Fall of 1975. Six actaully enrolled students, two additional ones offered courses which were cancelled for insufficient enrollment. There were three additional national project meetings in Spring of 1976, Fall of 1976 and Spring of 1977 during which the main activity was the sharing of implementation experiences via the vehicle of progress reports by each college to the larger group. In addition to this, each trial college was visited each academic year by the project director or assistant project director. The primary business conducted during these visits had to do with the details and experiences of the trial implementations.

2.1 In the Spring of 1976, 10 new colleges were invited to attend the project meeting. Of this ten, three colleges offered the program in the Fall of 1976 and on additional one came on stream in the Fall of 1977. In total 22 colleges had the opportunity to consider in depth the SET curriculum. Many of them were able to participate in and influence the design of the curriculum. Of the 22, 14 would ultimately offer some SET courses. These colleges represent all areas of the United States and include the full range from technical institutes to universities. The fact that not all of them would try the SET curriculum represents the fact that higher education was experiencing the leveling off of enrollments and with this a period of declining budgets. New curricular committments were not taken on as easily as they were during the go-go years of the sixties. The 14/22 trial rate is probably pretty good considering the times.

2.2 Of the 14 colleges that did try the curriculum in some form, nine actually stayed in to the point of teaching courses and proposing the curriculum through their administrative structure. In a couple of cases these proposals were not successful. There were some extreme financial problems inhibiting the support of new curricula, in some of the colleges, the continuance of a curriculum depends upon a combination of critical factors, the absence of one, of which cannot be compensated for by the presence of the others. Some of these difficulties are discussed in the SET Curriculum Guide. At the present time there are five institutions continuing to offer the SET curriculum.

2.3 The purpose of the trial implementation was two fold, to gain experience for use in the preparation of the curriculum and to disseminate the SET curriculum. No effort to recruit new colleges for SET was made since the Spring of 1976 because establishment of SET program was not really the goal of the project. Some Johnny Appleseed work was done in order to get an adequate sample of institutions for curriculum trials. It is felt that sufficient curriculum trial activity has been conducted for the purpose. Project attention has now been directed more to the Curriculum Guide and Study Guides which are being completed in final form. Dissemination of the SET curriculum by the distribution of such materials is much more cost effective than the expensive process of invitation, indoctrination, encouragement visits and sharing of experiences which was necessarily employed during the first three years of the project. There is evidence that dissemination by the distribution of materials may be working. The project office receives occasional inquiries from interested colleges. The SET Curriculum Guide has not yet been released. Several new colleges are waiting for this guide. The guide gives detailed instructions on how to start an SET curriculum. It is expected that there will be new schools trying the curriculum as the Curriculum Guide is distributed.

V. Study Guide Production:

During the early stages of trial implementation it was found that course outlines were not sufficient to achieve uniform implementation of the curriculum. Although the course outlines specified the topics, they did not specify the depth of coverage. It was decided that the development of study guides for use by the students would be the best method of insuring some uniformity of depth of coverage of the topics listed in the course outlines.

With the advise of the steering committee and the curriculum coordinators a format for the study guides and a development procedure were formulated. The study guides would address each topic listed in the course outline with a brief statement of principles. These statements would be followed by solved example exercises and student exercises. Where appropriate the study guides would contain a statement of objectives for laboratory exercise.

The development procedure consisted of several steps. The first, and sometimes most difficult, was to select an author. The ideal author was an expert in the subject and experienced in teaching at the two-year college level. It was also advantageous if the author was familiar with the SET curriculum. As a result most of the authors were faculty from the cooperating colleges.

Once the author was selected the development procedure of writing, reviewing, revising, field testing and revising began. The author wrote an initial draft which was reviewed by two other people (Curriculum coordinators, faculty, or steering committee members). Based on the reviewers suggestions, the author then revised the study guide and it was submitted to field testing. The field testing consisted of students utilizing the study guide in courses at the cooperating colleges. The feedback from the field trials was then incorporated into the final revision of the study guide.

A study guide was developed for each of the specialized courses in the curriculum. The titles and authors are listed below and the tables of contents are in appendix III.

Algebraic and Trigonometric Equations with Applications
by Roger Melton

Analog and Digital Electronics
by Vince Cavanaugh

Chemical Science and Technology I
by Jack Ballinger and Lawrence J. Wolf

Chemical Science and Technology II
by Jack Ballinger and Lawrence J. Wolf

Computer and Calculator Techniques
by Daniel Davidson and Jim Wesselmann

Differential and Integral Calculus
by Roger Melton

Electronic Components, Transducers and Basic Circuits
by Donald R. Mowery

Electronic Instrumentation
by John Fortna

Functions, Analytic Geometry, Probability and Statistics
by Roger Melton

Materials and Fabrication Methods I
by Andrew Lindberg, Richard Stevens, Robert Bay and Rudy Walker

Materials and Fabrication Methods II
by Andrew Lindberg and Robert Bay

Organization and Expression in Writing
by Marian McClintock

Physics of Electromagnetic, Optical and Solid State Sysyems
by Peggy Dixon, Bernard Schrautemeier and Gary Waldman

Physics of Mechanical, Gaseous and Fluid Systems
by Peggy Dixon, Bernard Schrautemeier and Gary Waldman

Science and Engineering Graphics I
by Jerry Craig and Jerry Stapleton

The project has distributed copies of these study guides and disseminated information concerning them. The cooperating colleges have been provided copies for use in their SET courses, and in some instances the study guides are being utilized for courses which are not part of the SET curriculum. Along with information concerning the SET curriculum, the study guides have been disseminated to a number of people expressing an interest in either the curriculum or individual study guides. Approximately 2500 study guides have been distributed to the cooperating colleges and other interested parties.

Because of the interest in the study guides by people not involved in SET an attempt was made to obtain a publisher for these materials. An announcement was mailed to 73 companies identified as publishers of college level materials in science and technology. Sample study guides were also sent and complete sets of study guides were sent to those publishers who indicated an interest in the materials. A publishers' briefing was held in April 1978, but of the 73 publishers invited only two were in attendance.

Because of the limited market for these specialized materials no publisher has been willing to publish them. As a result the project center will continue to make the study guides available to the cooperating colleges.

VI. Dissemination:

Throughout the project efforts were made to disseminate information concerning the curriculum and its study guides. The primary modes of dissemination were articles published in professional journals and papers presented to professional organizations. These articles and papers, written by project staff and curriculum coordinators are listed below:

Articles

"A Science and Engineering Curriculum for Technicians", Lawrence J. Wolf and Bill G. Aldridge, Engineering Education, May 1976.

"St. Louis, Missouri: The Multi-Person", Mosaic, May/June 1976.

"Science and Engineering Technology Curriculum," Donald R. Mowery, CRPTYC, December 1977.

"Articulation Between Associate Degree and Baccalaureate Programs in Engineering Technology Education," Lawrence J. Wolf, Annuals, Journal of Engineering Education, December 1978.

Papers

"The Science and Engineering Technician Curriculum Project," Lawrence J. Wolf, American Society for Engineering Education, Midwest Regional Conference, March 1976.

"Science and Engineering Technology - Leading New Students to New Jobs" Donald R. Mowery, American Associateion of Physics Teachers, National Meeting, June 1977.

"Curriculum Development in Science and Engineering Technology (An Interdisciplinary Approach)," Donald R. Mowery, American Technical Education Association, Region VI Conference, October 1977.

"Increasing Physics Involvement in Career Education" Donald R. Mowery, American Assoication of Physics Teachers - American Physical Society, Joint Meeting, January 1978.

"Engineering Technology Articulation Between a Community College and a University", LeRoy Holmes, American Society for Engineering Education, National Meeting, June 1978.

"A Science and Engineering Technology Two-Year Curriculum", John Zunes, American Society for Engineering Education, Annual Conference, June 1978.

"The Science and Engineering Technician Curriculum Project - A Final Report", Lawrence J. Wolf, American Society for Engineering Education, Annual Conference, June 1979.

In addition to the articles and papers information was disseminated through the distribution of brochures describing the curriculum and inquiries concerning the study guides were encouraged through the distribution of business reply post cards. When these cards were returned to the project center, sample copies of the requ ested study guides were mailed along with a letter offering assistance in implementing the curriculum. These materials were followed by a letter asking for comments about the study guides received and again offering assistance if implementation was being considered. These methods proved successful for dissemination of study guides but generated little interest in implementation of the SET curriculum without financial support from this project. There has, however, been some interest in implementation and copies of the completed curriculum guide are being mailed to those who requested them.

VII. Evaluation

The evaluation of this projects addresses two major areas of effort: the curriculum and the study guides. During the development of both evaluation for the purpose of revision was a continuous process. These evaluations were rather informal usually in the form of comments from the curriculum coordinators, the faculty and the students. The evaluation of the completed curriculum and study guides was conducted by Dr. Karen C. Cohen. This report is summarized here and included in its entirity in Appendix IV.

The evaluation surveyed three groups associated with the curriculum - students entering the curriculum, graduates of the curriculum and teachers of the curriculum. The entering students were surveyed to determine why they had selected the SET curriculum. The results indicate that flexibility was the most common expectation.

The survey of SET graduates covered the program and the study guides. The returns indicated that the graduates were prepared for employment and/or transfer to four-year colleges. The responses to the program were generally positive indicating that it is "better than average." The study guides were well received by the students who felt they were helpful and enabled them to learn more. They reported that the examples were helpful and clear and suggested that more be added. The reaction to the student exercises were mixed but no suggestions were offered for improving them. The graduates reported using the study guides in addition to other materials and resources, and they felt the study guides cannot be used without a teacher. This is in complete agreement with their intended use.

Teachers of SET courses were surveyed regarding the study guides and the curriculum itself. The responses concerning the study guides were favorable with the teachers liking the applications aspect of the materials and there organization. The teachers liked the curriculum's interdisciplinary nature but disliked the lack of in-depth experience with a discipline.

The evaluation of the curriculum and study guides can best be summarized by the following paragraph from Dr. Cohen's report:

> "Clearly here we have a situation in which the whole is greater than the sum of its courses. Those who follow through the entire SET program seem to be faring well and are happy with it despite quite varied reactions by individual teachers to specific courses. The Study Guides, the heart of the program, seem to be well organized, well done, well received and helpful to students and teachers alike."

Appendix I

Advisory Committee

Avtgis, Alexander--Wentworth Institute, Boston, MA

Bickel, William--University of Arizona, Tucson, AZ

Chapman, Kenneth--American Chemical Society, Washington, D.C.

Fath, Jack--Eastern Standards Laboratory Division, Washington Navy Yard, Washington, D.C.

Grant, John--Stanford University, Palo Alto, CA

Haberstroh, Robert--College of the Virgin Islands, St. Croix, Virgin Islands

Jackson, T.A.--Florida A & M University, Tallahassee, FL

McWane, John--Massachusetts Institute of Technology, Cambridge, MA

Melonakis, Mathew--Adolph Coors Co., Golden, CO

Meyer, Richard--McDonnell Douglas Corp., St. Louis, MO

Nemecek, Joseph--Trans World Airlines, Kansas City, MO

Rogowski, Lavern--Ball Brothers Research Corp., Boulder, CO

Skilton, Ronald--General Electric Co., San Francisco, CA

Smith, James--Texas Instruments, Dallas, TX

Walton, William--Education Development Center, Newton, MA

Wolf, Clarence--McDonnell Douglas Corp., St. Louis, MO

Wolf, Lawrence J.--Wentworth Institute, Boston, MA

Wolff, Norman--VACTEC, Inc., St. Louis, MO

Woolf, Kenneth--Delaware County Community College, Media, PA

Appendix II

Cooperating Colleges

Community College of Allegheny County, South Campus,
West Mifflin, PA
Pearley Cunningham, Curriculum Coordinator

Community College of Denver, North Campus, Denver, CO
Daniel Sukle, Curriculum Coordinator

Community College of Denver, Red Rocks Campus, Denver, CO
Alfred Bussian, Curriculum Coordinator

Florissant Valley Community College, St. Louis, MO
Bill G. Aldridge and Donald R. Mowery,
Curriculum Coordinators

Fort Hays Kansas State College, Hays, KS
Roger A. Pruitt, Curriculum Coordinator

Metropolitan State College, Denver, CO
E. J. Davies, Curriculum Coordinator

Modesto Community College, Modesto, CA
John Mudie and Leroy Holmes, Curriculum Coordinators

Montgomery College, Takoma Park, MD
Peggy Dixon, Curriculum Coordinator

Penn Valley Community College, Kansas City, MO
Norman Preston, Curriculum Coordinator

Pima College, Tucson, AZ
Daniel Davidson, Curriculum Coordinator

Richland College, Dallas, TX
Floyd King, Curriculum Coordinator

Westchester Community College, Valhalla, NY
Malcolm Goldberg, Curriculum Coordinator

APPENDIX III

ALGEBRAIC AND TRIGONOMETRIC EQUATIONS WITH APPLICATIONS

I. Linear Equations in Two Unknowns
- Definition of Function--Function Notation
- Linear Equations in Two Unknowns
- The Rectangular Coordinate System
- Graph of a Linear Function in Two Unknowns
- Distance Between Two Points in the Plane
- Slope of a line
- Equations of a Line
- Direct Variation (Data Analysis)

II. Trigonometric Equations and Vectors
- Angles and Their Measure
- Conversion From One Angular Measure to Another
- The Trigonometric Functions
- Solving Right Triangles
- Applications of Radian Measure
- Vectors--Geometric Interpretation
- Vectors as Ordered Pairs
- Computer and Calculator Applications

III. Systems of Linear Equations
- Two Linear Equations in Two Unknowns
- Solution of a System by Graphing
- Solving a System by Elimination--Addition or Substitution Method
- Solving a System Using Determinants--Cramer's Rule
- Three Linear Equations in Three Unknowns
- Solving a System--Elimination Method--Cramer's Rule
- Computer and Calculator Applications

IV. Quadratic Equations
- Quadratic Functions in One Unknown
- Roots and Zeros
- Finding Zeros of a Quadratic Function

V. Complex Numbers--Imaginary Roots of Quadratic Equations
- Complex Numbers
- Operations Involving Complex Numbers
- Imaginary Solutions of Quadratic Equations

VI. Equations Containing Fractions
- Rational Expresssions
- Operations Involving Rational Expressions
- Solving Equations Containing Fractions

VII. Exponential and Logarithmic Equations
- Exponential Form--Laws of Exponents
- Zero, Negative, and Fractional Exponents
- The Exponential Function $y = b^x$
- Logarithms--Properties of Logarithms
- Application of Logarithms--Solving Exponential Equations
- The Logarithmic Function

Appendix III
SET Study Guide Contents

ANALOG AND DIGITAL ELECTRONICS

I. Diodes
- Definition
- Power Diodes
- Electro-optical Devices
- Thyristors
- Zener Diodes
- Varactor Diodes

II. Transistors
- Introduction
- Bipolar Transistors
- Field Effect Transistors

III. Regulated Power Supplies

IV. Oscillators
- Introduction
- Wein Bridge Oscillator
- Crystal Oscillator
- Multivibrators
- Waveform Generators

V. Filter Circuits
- Low-Pass Filters
- High-Pass Filters
- Band-Pass Filters
- Integrators and Differentiators

VI. Digital Concepts
- Introduction
- Switching Circuits
- Combinational Logic
- Truth Tables

VII. Digital Electronic Circuits
- Logic Gate Symbols
- Timing Diagrams
- Integrated Circuits

VIII. Combinational Logic
- Truth Tables
- Circuit Synthesis and Analysis
- Boolean Algebra

IX. Binary Arithmetic
- Binary Numbers
- Complemented Numbers

Appendix III
SET Study Guide Contents

CHEMICAL SCIENCE AND TECHNOLOGY I

I. Chemical Laboratory Safety and Practices

- On the Prevention of Explosions, Fires and Great Bodily Harm
- Chemistry Laboratory Glassware, Hardware, and Beware
- Burners, Ovens, and Other Hot Things
- Pressure, Pressure Everywhere
- The Laboratory Notebook Versus the Paper Towel

II. Atomic Structure

- Atoms, Elements and Atomic Weights
- The Mole Concept
- The Periodic Table

III. Inorganic Chemistry

- Electronegativity
- Electron-Dot Structures
- Naming Inorganic Compounds

IV. Nuclear Chemistry

- Fission and Fusion
- Types of Radiation
- Rate of Radioactive Decay

V. Organic Chemistry

- Aliphatic Hydrocarbons
- Aromatic Hydrocarbons
- Functional Groups

Appendix III
SET Study Guide Contents

CHEMICAL SCIENCE AND TECHNOLOGY II

I. Solutions and Concentrations

- Concentration Expressions
- pH

II. Chemical Equations

- Balancing Chemical Equations
- Stoichiometry
- Theoretical and Actual Yields
- Limiting Reagent

III. Electrochemistry

- The Galvanic Cell
- The Corrosion of Iron and Steel
- Galvanic Corrosion
- Applied Electrochemistry
- Corrosion Control and Prevention

IV. Gas Laws

- Gas Pressure
- The Ideal Gas Law

V. Organic Materials

- Chemistry of Plastics
- Selection of Plastics
- Elastomers
- Adhesives

Appendix III
SET Study Guide Contents

COMPUTER AND CALCULATOR TECHNIQUES

I. Hand-held Electronic Calculators

- History and Principles
- Four Function Calculators
- Scientific Calculators
- Calculator Errors
- Estimation
- Significant Figures
- Problems for the Expert

II. Programmable Electronic Calculators

- Introduction
- Registers
- Instructions Found Only on Programmable Calculators
- Programming
- From Algorithms to Finished Programs

III. Computers

- Introduction
- Batch Processing
- The Interactive Terminal
- Programming Language
- BASIC Language

Appendix III
SET Study Guide Contents

DIFFERENTIAL AND INTEGRAL CALCULUS

I. Instantaneous Rate of Change

- Limit--Limit Notation
- Instantaneous Rate of Change

II. The Derivative

- The Derivative of a Function
- Differentiation Formulas
- Higher Order Derivatives--Implicit Differentiation

III. Applications of the Derivative

- Tangent and Normal Lines
- Related Rates
- Applications Involving Maximum or Minimum Function Values

IV. Antidifferentiation--The Indefinite Integral

- Using Differentials to Approximate Errors
- Antidifferentiation

V. The Definite Integral

- Finding Areas by Integration--The Definite Integral
- Approximating the Definite Integral--Trapezoidal Rule

Appendix III
SET Study Guide Contents

ELECTRONIC COMPONENTS, TPANSDUCERS, AND BASIC CIRCUITS

I. Basic Electrical Quantities

II. Test Instruments

III. Resistors and Resistance Circuits
- DC and AC Characteristics
- Series and Parallel Circuits
- Voltage Dividers
- Kirchoff's Laws

IV. Operational Amplifier
- The Op-Amp
- Inverting Amplifier
- Non-Inverting Amplifier
- AC Characteristics

V. Bridge Circuits
- DC Bridge
- AC Bridge

VI. Temperature Transducers
- Resistance Thermometer
- Thermistors
- Thermocouples
- Applications

VII. Power Amplifier
- Transistor Basics
- Power Amplifier

VIII. Recorders
- Chart Recorders
- X-Y Recorders

IX. Strain Gauge

X. Light Transducers
- Photoemissive Tubes
- Photovoltaic Cells
- Photoconductive Cells

XI. Sound Transducers
- Crystal Microphone
- Loudspeaker

XII. Linear Variable Differential Transformer

XIII. Differential Amplifier

Appendix III
SET Study Guide Contents

FUNCTIONS, ANALYTIC GEOMETRY, PROBABILITY AND STATISTICS

I. Variation
   - Direct Variation
   - Inverse Variation
   - Joint Variation

II. Polynomial Equations of Higher Degree
   - Polynomial Functions in One Variable
   - Roots and Zeros
   - The Graph of a Polynomial Function
   - The Remainder Theorem and Synthetic Division
   - The Factor Theorem
   - Roots of Higher Degree Polynomial Equations
   - Irrational Roots of Polynomial Equations

III. Analytic Geometry
   - Linear Equation in Two Unknowns--The Line
   - Distance Between Two Points and Slope of a Line
   - Equations of a Line
   - The Circle
   - The Parabola
   - The Ellipse
   - The Hyperbola

IV. Graphs of the Trigonometric Functions
   - Graphs of $y = a \cdot \sin b\theta$ and $y = a \cdot \cos b\theta$
   - Graphs of $y = a \cdot \sin (b\theta + c)$ and $y = a \cdot \cos (b\theta + c)$
   - Graphs of $y = \tan \theta$, $y = \cot \theta$, $y = \sec \theta$, $y = \csc \theta$

V. Counting and Probability
   - Counting: The Multiplication Principle
   - Counting: The Addition Principle
   - The Multiplication and Addition Principles Together
   - Pwrmutations and Combinations
   - Mathematical Probability
   - Empirical Probability

VI. Statistics--Curve Fitting
   - Tabulation of Data
   - Mean, Median, Mode
   - Standard Deviation
   - Curve Fitting--Linear Empirical Equation

Appendix III
SET Study Guide Contents

ELECTRONIC INSTRUMENTATION

I. Instrumentation Systems

- Introduction
- Classification of Instruments
- Basic Building Blocks
- The Total Instrument/Instrumented System

II. Basic Laboratory Instruments

- Function (Signal) Generator
- Frequency Meter/Interval Timer
- The Voltmeter
- Ammeter
- Oscilloscopes
- Measurement of Passive Components

III. Other Sensing and Measuring Instruments

- Integrated Circuits as the Basic Instrument Building Block
- A Look at the Basic Instrument
- Processors
- Input
- Output

IV. Power Supplies

- Introduction
- Voltage and Current Generator Theory
- Voltage Regulated Power Supply
- Other Power Supplies
- DC-AC and DC-DC Conversion
- Despiking, Filtering and System Considerations
- Surge Suppression
- Environmental Factors

V. Instrumentation

- Coupling Requirements
- Instrumentation Systems
- Noise in Measurement Systems

Appendix III
SET Study Guide Contents

MATERIALS AND FABRICATION METHODS I

I. Measurements
- Metric Units (SI) and English Units
- Measuring Instruments
  - Length--Vernier Calipers, Scales and Tapes
    Dial Indicators
  - Angle Measurement
  - Speeds and Feed Rate
- Layout, Radius, and Hole Gauges

II. Electrical Fabrication
- Symbols and Schematics
- Components
- Wiring Types and Identification
- Soldering
- Circuit Fabrication
- Instrumentation Wiring

III. Hand Tools
- Safety
- Vises and Gripping Tools
- Material Removing Tool
- Punches and Chisels and Impact Tools
- Drills and Reamers
- Threads and Fasteners

IV. Power Hand Tools
- Safety
- Hand-held Drill Motors
- Saber and Power Saws
- Staplers and Power Riveting
- Routers
- Sanders and Grinders
- Impact Tools

V. Power Bench Tools
- Safety
- Drill Press
- Grinder
- Band Saw
- Table Saws

VI. Metal Fabrication
- Safety
- Shearing and Punching
- Braking and Rolling
- Spot Welding and Soldering
- Fasteners
- Bonding and Cementing

Appendix III
SET Study Guide Contents

MATERIALS AND FABRICATION METHODS II

I. Welding, Soldering and Brazing
   - Introduction
   - Arc Welding
   - Gas Welding
   - Brazing
   - Oxygen-Acetylene Torch Cutting
   - Silver Soldering

II. Plastics Fabrication
   - Types, Properties and Identification
   - Safety
   - Machining, Fasterners, Bonding, Forming and Molding

III. Tubing and Piping Fabrication
   - Introduction
   - Symbols and Schematics
   - Components
   - Tubing Systems
   - Soldering and Bonding of Copper, Steel and Plastic Pipe Tubing Systems
   - Gaskets and Seals

IV. Materials' Properties and Testing
   - Material Properties and Tests
   - Selection and Ordering of Materials

V. Heat Treating
   - Introduction
   - Hardness Testing
   - Strain Hardening and Annealing
   - Alloying and Crystal Structure
   - Quench Hardening of Ferrous Metals

VI. Finishes
   - Types and Identification
   - Application
   - Surface Preparation
   - Paints, Lacquers, Varnishes and Primers
   - Identification and Uses of Plating

Appendix III
SET Study Guide Contents

ORGANIZATION AND EXPRESSION IN WRITING

I. Reading Efficiently
   - Scanning
   - Skimming
   - Reading for Comprehension
   - Reading Specialized Material

II. Use of the Library and Its Resources
   - Kinds of Resources Available
   - Organization of Library Facilities and Resources

III. Principles of Organization
   - Planning
   - Writing the Thesis Statement
   - Choosing the Organizational Pattern

IV. Writing the Summary
   - Basic Types of Summaries
   - Writing the Summary

V. Writing and Reading Definitions
   - Definition and Examples
   - Writing the Definition
   - Reading Definitions

VI. Explaining a Process
   - Definition
   - Method of Writing the Process Paper

VII. Classification
   - Definition and Examples
   - Writing the Classification Paper
   - The Outline

VIII. Comparison and Contrast
   - Definition of Comparison and Contrast
   - Writing the Comparison/Contrast Paper

IX. Diction
   - Definition
   - General Principles and Examples

X. The Paragraph
   - Definitions and Examples

XI. Coherence
   - Definition

Appendix III

SET Study Guide Contents

PHYSICS OF ELECTROMAGNETIC OPTICAL AND SOLID STATE SYSTEMS

I. Electromagnetism
   - DC Circuits
   - Electrostatics
   - Magnetism I (Magnetic Induction Field)
   - Magnetism II (Magnetic Forces)
   - Basic Measuring Instruments
   - Electromagnetic Induction; Self and Mutual Inductance
   - AC Circuits

II. Optics
   - Electromagnetic Waves
   - Basic Geometrical Optics
   - Optical Instruments
   - Physical Optics
   - Photometry
   - Quantum Optics

III. Solid-State and Nuclear Physics
   - Atomic Structure and Solid State Physics
   - Nuclear Physics

Appendix III
SET Study Guide Contents

PHYSICS OF MECHANICAL GASEOUS AND FLUID SYSTEMS

I. Basic Concepts
   - Length and Time
   - Mass and Weight
   - Measurement and Error; Accuracy; Precison
   - Basic Electrical Concepts

II. Translational Motion
   - Distance
   - Speed and Velocity
   - Acceleration
   - Linear Momentus and Its Conservation
   - Newton's Laws of Motion: Gravitation
   - Work; Energy; Power

III. Rotational Motion
   - Centripetal Force
   - Rotational Angle, Velocity, Acceleration
   - Torque and Static Equilibrium
   - Moment of Inertia; Rotational Energy

IV. Temperature and Heat
   - Temperature Scales and Measurements
   - Specific Heat
   - Transfer of Heat

V. Properties of Gases and Liquids
   - Density, Specific Gravity, Archimedes Principle
   - Phase Changes
   - Pressure and Its Measurement
   - Gas Laws
   - Hydrodynamics

VI. Sound and Wave Motion
   - Basic Wave Properties
   - Superposition, Standing Waves, and Harmonics
   - Sound Power, Intensity, and Decibels

Appendix III
SET Study Guide Contents

SCIENCE AND ENGINEERING GRAPHICS I

I. Introductory Topics
   Lettering
   Use of Equipment

II. Geometrical Construction
   Basic Applied Geometry

III. Sketching and Shape Description
   Sketching Materials and Lines Technique
   Isometric Sketching

IV. Multiview Projection
   Theory of Projection
   Instrument Drawing

V. Auxiliary Views
   Primary Auxiliary Views

VI. Sectional Views
   Cutting Planes, Section Lining, Full and Half Sections
   Other Types of Sectioned Views

VII. Basic Dimensioning
   Means for Specifying Dimensions
   Standard Methods of Dimensioning Features
   Special Dimensioning Notes and Symbols
   Tolerancing

VIII. Electrical and Electronic Drafting
   Block Diagrams
   Connection Diagrams and Interconnection Diagrams
   Schematic Diagrams
   Logic Diagrams, Integrated Circuits, Printed Circuits

IX. Welding Drawing
   Processes, Joints, and Symbols

X. Pipe Drawing
   Joints, Fittings, and Valves
   Single-Line and Double-Line Drawing

XI. Charts and Graphs
   Rectangular Line Graphs
   Semi-Logarithmic Line Chart or Graph

Appendix IV

SUMMARY EVALUATION FINDINGS AND RECOMMENDATIONS FOR PROJECT SET[1]

by

Karen C. Cohen Ph.D.

[1]Project SET is supported by Grants HES74-2284 and GA-3387 from the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in this report are those of the author and do not necessarily reflect the views of the National Science Foundation.

Copyright © 1979, Karen C. Cohen, Ph.D.

Introduction and Methodology

Relatively recently I was asked to help evaluate Project SET, a program which has been in existance for several years. Project SET (Science and Engineering for Technicians) has developed a series of study guides designed to teach generic science and engineering skills to students interested in becoming technicians. An entire two-year curriculum is encompassed by these guides, geared for two-year college students. Although originally devised for teachers, the direction of the Project is currently to provide both teachers and students with these guides. The Project is centered at St. Louis Community College at Florissant Valley, St. Louis, Missouri and involves a small consortium of other institutions.

Since its inception, the Project had undergone many changes in leadership and, during the present academic year (when the data reported upon here was gathered), it continued under somewhat chaotic conditions; our findings, thus, are somewhat limited. We received more survey returns from teachers than students involved in the program (14 vs. 12) and only 5 follow-up surveys from graduates of the program or students near its end. All reports are from three community colleges: St. Louis, Allegheny, and Durham.

Of prime concern to the evaluation was the level, quality and effectiveness of the material and the program, both from the student and teacher points of view. Initially, a multi-tiered evaluation effort using questionnaires for teachers, coordinators, students and graduates, along with telephone interviews of members of all such groups was proposed. A separate "career" component was also planned, aimed at understanding how career guidance efforts at each institution dove-tailed with program goals, needs and enrollment. Budget cuts and decisions of the director limited the evaluations to three

questionnaires, developed by the evaluator, administered by the Project, and returned to the evaluator. Thirty-two teachers were sent questionnaires, and a total of seventy-eight students and graduates were sent questionnaires. Returns received were 14 teacher surveys, 12 pre-program student surveys, and five post-program graduate surveys. There are several possible reasons for the relatively small number of returns:

-- A small number of students actually enrolled in and completed the program,

-- Participation was voluntary and anonymous,

-- Multi-tiered coordination, involving at least four different coordination steps (evaluator-to project director-to coordinators-to teachers-to students), may not have been efficient.

Nevertheless, we do have some returns, and the findings are in some instances intriguing. With such small numbers, however, results should be regarded as potentially indicative rather than definitive.

Copies of the three instruments and complete results appear in the Appendices of this report.

Pre-Program Survey Findings

In the pre-program survey, we were interested in learning why students had selected the SET program and what their initial reactions were to their Study Guides. Some of the same items were repeated in the post-program survey to abet comparisons. Twelve students returned pre-program surveys from the three schools mentioned: St. Louis (2); Allegheny (6); and Durham (4).

The students listed many reasons for entering the program:

-- Interest in it;

-- High quality of instruction;

-- Equipment available;

-- Desire not to be limited/Many aspects to branch into;

-- Good reputation/Good program;

-- Help in advancement/More money after graduation;

-- Help in understanding one's work; and

-- Obtains pleasure from engineering.

Their reasons seem to be fairly positive and optimistic. When asked what they expected to gain by taking the SET curriculum against a fixed set of options (Question 3), the students responded as follows:

-- 9 expected flexibility in job prospects,

-- 7 expected practical, "hands-on" training,

-- 5 expected a technician's job,

-- 5 expected to transfer to a four-year college, and

-- 2 expected extra, extensive contact with their instructor.

Clearly then, the flexibility from a general program seemed to be the most common expectation.

All of the students had had previous courses they felt would provide useful background for the program. The courses they listed were all in science, mathematics or engineering (see Appendix for full list). Only one student had not received information about, or an explanation of, the Study Guides used in the program, and student expectations (once again, against a fixed set of options), were that using the Study Guide would:

-- Require less time to learn the same amount of material (8 yes, 3 no),

-- Enable them to learn more material than usual (8 yes, 3 no),

-- Not enable them to learn without help from instructors (8 yes, 3 no)*,

-- Make learning easier than usual (7 yes, 4 no),

-- Not result in less contact with the instructor (7 yes, 3 no)*.

Students, optimistic about the program, seemed equally optimistic about the Study Guides and using them, although they definitely anticipated an "usual" or "traditional" amount of interaction with the teacher would be part of the program.

No other questions were asked on the Pre-program Survey.

---

*These items are reversed in the questionnaire for several reasons; they are reversed in the reporting for ease of reading and comprehension.

Post-Program Survey Findings

The Post-Program Survey was far lengthier and more substantial than the Pre-Program Survey -- unfortunately only a small number responded. The survey covered job/career/educational activities and prospects, reactions to the SET program in general, and reactions to the Study Guides specifically.

All (5) respondents anticipated attending a four-college college, and two were already enrolled. One also planned to work as a "Plotter Operator" along with, and perhaps to help finance, attendance at a four-year college. The schools listed were:

-- Pennsylvania State University (2),

-- PITT

-- SIU

-- Washington University, and

-- Point Park College.

Not knowing more about the other program completers, it is difficult to understand why all were at or about to start four-year colleges. Perhaps selective follow-through is a factor -- it is easier to reach, via transcripts, students who continue and transfer credits to another school. Perhaps selective admissions and recruitment in the early years of the program was a factor. Perhaps the program was a factor. It would be interesting to follow the program, if continued, longitudinally to see if it actually serves to enhance four-year college attendance more than employment as technicians. It is possible that it does both. Given the high rate of two-year college students who do go on to four-year colleges, the results may not be surprising and should certainly be explored in greater depth.

Of the five Post-Program respondents, only one was currently employed as a technician (previously mentioned). These graduates were asked to rate their overall experience with the SLT program on a 5-point scale (1 = low; 5 = high) on several dimensions. On all dimensions responses indicated the program was better than average, with the possible exception of the value of the Study Guides (which were just about average or less than average). More specifically, the average ratings on the following dimensions were:

- -- Preparation for a technician's job 3.8
- -- Useful, practical experience 3.8
- -- Instructor Preparation 3.8
- -- Preparation for further education 3.6
- -- Usefulness of Study Guides 3.2 = 2.8*

Students were then asked to respond "yes" or "no" to a series of questions about the Study Guides similar to those on the pre-program survey. The following table summarizes their responses to the materials in the program:

Did using the Study Guide:	YES	NO
-- Make learning easier than usual?	4	1
-- Make learning more difficult than usual?	0	5
-- Result in less contact with the instructor?	2	3
-- Require additional explanation from your instructor?	4	1
-- Enable you to learn more material than usual?	4	1
-- Enable you to learn at your own pace?	4	1
-- Enable you to learn without help from your instructor?	3	2
-- Require less time to learn the usual amount of material?	2	3

*Inverted, as previously explained, for technical reasons and ease of reader comprehension.

In general, then, the Study Guides were well received by the students, but there is no indication that they can be used in self-study or stand-alone fashion. Students report they were helpful and enabled them to learn more, but they quite definitely cannot be used without a teacher.

All students felt the directions in the guides were clear (N = 5); three used them in the order presented, while two did not. Reasons for "deviation" were lack of equipment for the class and the teacher's not using it with the class as a book. All students used materials and resources in addition to the Guides. The other resources were primarily texts, and a full listing appears in the Appendix.

Four of the five graduates reported their teachers did not skip any parts of the guide even though they may have varied the order.

As for their practicum or laboratory experiences, students found them primarily helpful (5 out of 5). Two felt they were clear, one confusing, and none too easy or too complicated. They had suggestions for improving the laboratory experience:

-- Give more preparations for equipment use, and

-- Make sure the experiments work!

Student reactions to the examples in the Study Guide parallelled to a great extent their reactions to the practica: all 5 felt the examples were helpful, 3 found them clear, none found them confusing or too complicated, and one said they were too easy. The only suggestion regarding examples was that more be added.

Students were not quite as unanimous about the student exercises (euphemism for homework), but three found them challenging, two a fair test of learning, one too easy, one too hard, one just right, and none ambiguous. There were no suggestions for improving the student problems or exercise sets.

Graduates did have suggestions about improving the SET curriculum in general. Most briefly they focussed on two areas -- college opportunities and practical (important) considerations. In terms of college, students felt more cooperation was needed between major universities and those institutions with the SET program, and that change was needed to make SET more transferable to a four-year college. On the technical or functioning side, students felt there could be more practical and useful projects, more work by students on general evaluations of maintenance practices, and more student repair of school equipment (an additional request for practical experience?).

None of the five graduates felt at all disaffected with the program. Their responses were clear, targeted, and generally positive.

Teacher Survey Results

Teachers were asked in even more detail than students about the SET program. Of the fourteen instructors who responded anonymously, only one was new to the program, i.e., had been involved for one quarter of a school year. The average involvement was 4.4 semesters. The entire list of courses in the SET curriculum was presented, and the most popular courses, i.e., those most frequently taught, were:

-- Algebraic and Trigonometric Equations and Applications (N = 4),

-- Materials and Fabrication Methods I (N = 3), and

-- Boolean Algebra (N = 3).

All of the other courses had been taught by one or two different teachers with the exception of a few courses no respondents reported offering:

-- Electronic Components, Transducers and Basic Circuits,

-- Technical or Applied Science Elective,

-- American History, American Civilization of other Social Sciences,

-- Calculus III,

-- Research Applications,

-- Human Relations, Personal Relations or alternative course,

-- Technical or Applied Science Elective, and

-- Research Practicum.

All of the courses reported taught as part of the SET curriculum were clearly delineated as scientific, mathematical or technical.

Similarly, in terms of non-SET courses previously taught, 44 were listed (see Appendix). Of the 44 courses listed only three were non-science -- English Literature and Remedial English. Teachers similarly had participated in a wide variety of two-year career programs; of the 29 programs listed (see Appendix),

26 were science/engineering/mathematics; two were business or general, and one was English. Teachers typically were male, had an M.A. or M.S. degree in science or engineering, and about 7-10 years experience. The backgrounds and experiences of the SET teachers seem well suited to the content of the program.

Teachers were then presented with a list of 13 SET Guides. They were asked if they had used them or not and if so, to rate them in terms of other materials comparable to SET Study Guides. Although we had responses for all but one guide, no more than two teachers had used any single guide, and most had been used by only one reporting teacher. Opinions of the individual guides varied enormously (see Appendix), but since each rating is based on an N of 1 or, at most, 2, results are neither reported nor discussed in the text (Question 6).

Teachers were then asked to compare their teaching experience in the SET program with other teaching experiences against several criteria. On a scale where 1 = low and 5 = high, the following general ratings emerged:

ITEM	RATING	N
Students learn to apply scientific principles to practical problems	3.1	11
Students learn to master technical concepts	3.5	11
Students practice writing technical reports	3.3	11
Students are able to apply their knowledge to new situations	3.2	10
Students know enough math to solve practical problems	3.4	10
Students are motivated to learn the material presented in class	3.6	11
Most students complete required assignments	3.6	11
Students seem to enjoy learning the material	3.5	10
Students are confident about their problem-solving ability	3.5	8

	RATING	N
Students learn from their work experiences outside the classroom	4.0	9
Students perform better on class examinations	3.2	11
The structure of the syllabus is well organized	3.7	10
Technical concepts and scientific principles are well explained by the texts and other materials	4.1	9
The materials are easy to use	4.2	10
The content of the curriculum is at high level	2.8	11
Students can readily transfer to a 4-year college or university	3.3	10

Clearly the highest ratings involve the ease of using the materials, the good explanations of concepts and principles and the integration of work experiences outside the classroom to enhance learning. The only "below-average" rating was to the comment that the materials are at a high level. Of possible interpretations of this finding, i.e., that they are low level or not too high, given the other responses concerning ease of use, etc., it is likely that not being at a high level indicates not too difficult rather than of poor quality.

When asked additional questions about the program (Question 8), teachers on the whole would recommend the SET materials to a new teacher, feel the Study Guides can be used in other classes, and are fairly undecided as to whether the program must be used in its entirety to be effective, whether they have more flexibility in teaching with it, and whether using the Guides creates problems not found with texts.

Teachers most liked the applications aspect of the materials, the workbooks (Study Guides) themselves and their organization, the program's approach,

its interdisciplinary nature, and the preparation for a technical education it encompasses. Their dislikes at present involve the broad range and/or lack of enrolled students, exaggerated claims about transfer potential, and lack of in-depth experience with a discipline. Other comments, both positive and negative, tended to be more idiosyncratic and appear in the Appendix.

Discussion and Conclusions

The SET program is apparently fairly well received by those small numbers of individuals involved with it. Although there may be indications that it accomplished transfer to a four-year college more often than entry into the job market at the technician level, we cannot draw any firm conclusions about what is happening until we know of initial aspirations of applicants, track them through the program, compare them with other "equivalent" groups, and assess this component of the program.

Clearly here we have a situation in which the whole is greater than the sum of its courses. Those who follow through the entire SET program seem to be faring well and are happy with it despite quite varied reactions by individual teachers to specific courses. The Study Guides, the heart of the program, seem to be well organized, well done, well received and helpful to students and teachers alike.

All of the findings reported and statements made are bullish and should be interpreted as potentially illustrative. In no way can findings from such small and potentially skewed populations be regarded as definitive. It would be of interest to follow the Study Guide notion, as embodied in the SLT and other curricula, to see if they diffuse more effectively over time than the totally "teacher proof" curricular packages so often developed in the '60s. Such a task is far larger than evaluating the impact of the SET program.

The approaches used here can be continued as enrollments grow and more graduates exit. Better coordination of the survey effort could also yield a higher percentage of returns.

S.E.T. CURRICULUM

Pre-Program Survey

1. Name of College _____

2. Date _____

3. Why did you select the S.E.T. Program as compared to other options available to you? What other options did you consider?

Which of the following do you expect to gain by taking the S.E.T. curriculum? (Check all that apply.)

4. _____ technician's

5. _____ transfer to a four-year college

6. _____ flexibility in job prospects

7. _____ practical, "hands-on" training

8. _____ extra, extensive contact with your instructor

9. Please list those courses and/or work experience you have recently completed that you feel will provide the most useful background for the S.E.T. Program.

10. Have you alread received information or explanations of the Study Guides used in the S.E.T. courses?

_____ Yes _____ No

If you answered "yes" to the above question, please answer the following question. Do you expect that using the Study Guide will: (circle your answers)

11.	require less time to learn the same amount of material	yes	no
12.	make learning easier than usual	yes	no
13.	enable you to learn without help from your instructors	yes	no
14.	enable you to learn more material than usual	yes	no
15.	result in less contact with your instructor	yes	no

Responses To
Pre-Program Survey

1. ----------

2. ----------

3. Interest
   Quality of instruction
   Equipment
   Didn't want to be limited
   More money after graduation
   Good reputation
   Many aspects to branch into
   Good program
   Gets pleasure from engineering
   Help in future advancement
   Help understand work

4. Five

5. Five

6. Nine

7. Seven

8. Two

9. Electronics Introduction
   Digital
   Calculus
   Instrumentation
   Engineering Material
   Machine Mechanics
   Technologist, Electrical Repair and Design
   Programming (Introduction)
   Building Computers
   Algebra I and II
   Trigonometry
   Physics and Technical Physics
   Mechanical Drawing
   Electronics
   USAF Site Development School
   Four years of industrial drafting experience
   Three years as Nuclear Processing Technician

	YES	NO
10.	11	1
11.	8	3
12.	7	4
13.	3	8
14.	8	3
15.	4	7

Post-Program Survey

1. College _____

2. Date _____

What are your current prospects for the immediate future? (check all that apply)

3. ____ attend four year college (which): _____

4. ____ work as a technician

5. ____ work in other type of job (what kind): _____

6. ____ unemployment

7. ____ other (please specify): _____

8. Are you currently attending a four year college? _____ Yes _____ No

9. Do you have a technician's job at present? ____ Yes ____ No

Please rate your overall experience of the SET PRogram on the following scales:

10.	very poorly prepared for technician's job	1	2	3	4	5	very good preparation for technician's job
11.	very poorly prepared for further education	1	2	3	4	5	very good preparation for further education
12.	little useful practical experience	1	2	3	4	5	much useful practical experience
13.	instructors were poorly prepared	1	2	3	4	5	instructors were very well prepared
14.	Study Guides were not useful	1	2	3	4	5	Study Guides were very useful

Did using the Study Guide: (circle your answers)

15.	make learning easier than usual?	yes no
16.	make learning more difficult than usual?	yes no
17.	result in less contact with your instructor	yes no
18.	require additional explanation from your instructor?	yes no
19.	enable you to learn more material than usual?	yes no
20.	enable you to learn at your own pace?	yes no
21.	enable you to learn without help from your instructor?	yes no
22.	require less time to learn the usual amount of material?	yes no

23. Were the directions contained in the Study Guides clear and helpful?

____ Yes ____ No

24. If you answered "no", please explain why

25. Did you use the material in the order in which it was presented in the Study Guides?

____ Yes ____ No

26. If you answered "no", please explain why.

27. Did you use any additional sources of information other than the Study Guides?

____ Yes ____ No

28. If you answered "yes", please list your other sources.

29. Did your instructors skip any sections in the Study Guide? ____ Yes ____ No

30. If you answered "yes", please list the sections skipped.

Did you find the practicums or laboratory experiences to be: (check all that apply)

31. ____ confusing
32. ____ helpful
33. ____ clear
34. ____ too easy
35. ____ too complicated

36. Please list any suggestions you might have for improving the practicums or laboratories.

Did you find the examples in the Study Guides to be: (check all that apply)

37. ____ confusing
38. ____ helpful
39. ____ clear
40. ____ too easy
41. ____ too complicated

42. Please list any sugestions you have for improving the examples in the Study Guides.

Did you find the student questions or exercise sets in the Study Guides to be: (check all that apply)

43. ____ too easy
44. ____ just the right amount of difficulty
45. ____ too difficult
46. ____ ambiguous
47. ____ challenging
48. ____ a fair test of your learning

49. Please list any suggestions you have for improving the student problems or exercise sets in the Study Guides.

50. Please list any other suggestions you have for improving the Study Guides or the ways they were used in your courses.

51. Please list any suggestions you have for improving the SET curriculm in general.

Responses To Post-Program Survey

1. ----------

2. ----------

3. Pennsylvania State University
   Washington University
   PITT
   Point Park
   Pennsylvania State - Capital
   SIU

4. None

5. Plotter Operator (1)

6. N/A

7. N/A

8. 2 Yes 3 No

9. 1 Yes 3 No

10.	(5) 1	(3) 2	(4) 3	(4) 4	(3) 5	3.8
11.	(4) 1	(2) 2	(4) 3	(4) 4	(4) 5	3.6
12.	(4) 1	(4) 2	(4) 3	(5) 4	(2) 5	3.8
13.	(4) 1	(4) 2	(4) 3	(4) 4	(3) 5	3.3
14.	(4) 1	(4) 2	(4) 3	(3) 4	(1) 5	3.2

	YES	No
15.	4	1
16.	0	5
17.	2	3
18.	4	1
19.	4	1
20.	4	1
21.	3	2
22.	2	3

23. 5 Yes 0 No

24. ----------

25. 3 Yes 2 No

26. Didn't use as class book.
Not enough equipment to go around.

27. 5 Yes 0 No

28. Books required for classes:
TTL Cookbook
CMOS Cookbook
OP Amp Cookbook
Manufacturer; Data
[illegible]ctor

Textbooks:
Electronics Communication
Digital Technology
Control Process Instrumentation
Technology

29. 1 Yes 4 No

30. ----------

31. One

32. Five

33. Two

34. None

35. None

36. Make more preparations for equipment use.
Make sure experiments work.

37. None

38. Five

39. Three

40. One

41. None

42. Add more examples.

43. One

44. One

45. One

46. None

47. Three

48. Two

49. ----------

50. ----------

51. More cooperation needed between major universities and those which have the SET Program.
Change needed to make it more transferable to a four year college.
More practical and useful projects.
Use students to do some general evaluations of maintenance practices.
More student repair of school equipment.

Teacher Survey

1. How long have you been involved with the SET Program?

_____ semesters (if your institution is on the semester system)
_____ quarters (if your institution is on the quarter system)

2. What courses within the SET curriculum have you taught? (please check as many as applicable)

_____ Materials and Fabrication Methods I
_____ Computer and Calculator Techniques
_____ Mechanical and Electrical Drawing and Interpretation
_____ Physics of Mechanical, Gaseous, and Fluid Systems
_____ Algebraic and Trigonometric Equations with Applications
_____ Analytic Geometry and Calculus I
_____ Electronic Components, Transducers, and Basic Circuits
_____ Materials and Fabrication Methods II
_____ Physics of Electromagnetic, Optical, and Solid State Systems
_____ Organization and Expression in Writing
_____ Functions, Analytic Geometry, Probability and Statistics
_____ Analytic Geometry and Calculus II
_____ Analog and Digital Electronics
_____ Chemical and Physical Properties of Materials
_____ Technical or Applied Science Elective
_____ American History, American Civilization, or other Social Science
_____ Boolean Algebra, Differential and Integral Calculus
_____ Calculus III
_____ Research, Development, Testing, or Engineering
_____ Applications Practicum (or equivalent experience)
_____ Electronic Instrumentation: Calibration, Measurement, and Control
_____ Technical Communications in Written and Oral Reports
_____ Human Relations, Personal Relations, or alternative course
_____ Chemical Sampling and Analysis
_____ Technical or Applied Science Elective
_____ Research, Development, Testing, or Engineering Applications
_____ Practicum (or equivalent experience)

3. How long have you taught in a Community College?

_____ years

4. Before becoming involved with the SET Program, what courses did you teach?

_____

_____

_____

_____

_____

_____

5. Before becoming involved with the SET Program, what two-year career program did you participate in?

_____

_____

_____

6. One objective of the SET Program has been to prepare new instructional materials for use in the classroom. Thte titles of thirteen of the Study Guides are listed on the next page. Please check which of the Guides you have used in your class. For those that you have used, please rate how each compares with other texts or educational materials you have used to teach a similar subject before you had the SET materials.

	Have Used	Have Not Used	Other Materials Preferable	Other Materials Comparable to SET Study Guides			SET Materials Preferable
a) Algebraic and Trig. Equiations with Applications	___	___	1	2	3	4	5
b) Chemical Science and Technology I	___	___	1	2	3	4	5
c) Chemical Science and Technology II	___	___	1	2	3	4	5
d) Computer and Calculator Techniques	___	___	1	2	3	4	5
e) Differential and Integral Calculus	___	___	1	2	3	4	5
f) Electronic Components, Transducers and Basic Circuits	___	___	1	2	3	4	5
g) Functions, Analytic Geometry, Probability and Statistics	___	___	1	2	3	4	5
h) Materials and Fabrication Methods I	___	___	1	2	3	4	5
i) Materials and Fabrication Methods II	___	___	1	2	3	4	5
j) Organization and Expression in Writing	___	___	1	2	3	4	5
k) Physics of Electromagnetic, Optical and Solid State Systems	___	___	1	2	3	4	5
l) Physics of Mechanical, Gaseous and and Fluid Systems	___	___	1	2	3	4	5
m) Science and Engineering Graphics	___	___	1	2	3	4	5

57/A

57/B

7. Please compare your teaching experience in the SET Program to other teaching experiences you have had within the last five years in community college programs in terms of the following criteria:

	Other Programs Definitely Preferable		Other Programs About the Same as SET Program		SET Program Definitely Preferable
a) Students learn to apply scientific principles to practical problems	1	2	3	4	5
b) Students learn to master technical concepts	1	2	3	4	5
c) Students practice writing technical reports	1	2	3	4	5
d) Students are able to apply their knowledge to new situations	1	2	3	4	5
e) Students know enough algebra, trig-nometry & calculus to solve practical problems	1	2	3	4	5
f) Students are motivated to learn the material presented in class	1	2	3	4	5
g) Most students complete required assignments	1	2	3	4	5
h) Students seem to enjoy learning the material in the course	1	2	3	4	5
i) Students are con-fident about their ability to solve problems	1	2	3	4	5
j) Students learn from their work experiences outside the classroom	1	2	3	4	5

	Other Programs Definitely Preferable		Other Programs About the Same as SET Program		SET Program Definitely Preferable
k) Students perform better on class examinations	1	2	3	4	5
l) The structure of the sylabus is well organized	1	2	3	4	5
m) Technical concepts and scientific principles are well explained by the texts and other materials	1	2	3	4	5
n) The materials are easy to use	1	2	3	4	5
o) The content of the curriculum is at high level	1	2	3	4	5
p) Students can readily transfer to a 4-year college or university	1	2	3	4	5

8. We would like your reactions to the following statements:

	Strongly Agree	Agree Somewhat	Undecided	Somewhat Disagree	Strongly Disagree
a) To a new teacher at this school I would recommend the SET materials	1	2	3	4	5
b) SET must be used as a complete program to be effective	1	2	3	4	5
c) SET Study Guides can be used in other classes	1	2	3	4	5
d) SET Study Guides allow me more flexibility in teaching	1	2	3	4	5
e) SET Study Guides create problems you don't find with texts	1	2	3	4	5

9. a. What is the highest academic degree you have recieved?

_____ BA/BS _____ PhD/ScD

_____ MA/MS _____ Other (Please specify) _____

b. What field is your degree in?

_____ Sciences: discipline _____

_____ Engineering: discipline _____

_____ Social Sciences: discipline _____

_____ Humanities: discipline _____

c. When did you recieve your degree? _____

10. What is your sex?

_____ Male

_____ Female

11. What I like most about SET is:

12. What I dislike most about SET is:

13. Other comments:

If envelope is lost, return to:

Donald Mowery, Project Director
Science and Engineering Technology Project
St. Louis Community College at Florissant Valley
3400 Pershall Road
St. Louis, Missouri 63135

Thank you for your help.

Responses To Teacher Survey

1. Semesters: 3, 5, 5, 6, 4, 6, 2, 2, 6, 6, 1. Mean = 4.4
   Quarters: 5, 4, 1. Mean = 3.3
   No Response: 0

2.
- 3 Materials and Fabrication Methods I
- 2 Computer and Calculator Techniques
- 2 Mechanical and Electrical Drawing and Interpretation
- 1 Physics of Mechanical, Gaseous, and Fluid Systems
- 4 Algebraic and Trigonometric Equations with Application
- 1 Analytic Geometry and Calculus I
- 0 Electronic Components, Transducers, and Basic Circuits
- 2 Materials and Fabrication Methods II
- 1 Physics of Electromagnetic, Optical, and Solid State Systems
- 1 Organization and Expression in Writing
- 1 Functions, Analytic Geometry, Probability and Statistics
- 1 Analytic Geometry and Calculus II
- 2 Analog and Digital Electronics
- 1 Chemical and Physical Properties of Materials
- 0 Technical or Applied Science Elective
- 0 American History, American Civilization, or other Social Science
- 3 Bollean Algebra, Differential and Integral Calculus
- 0 Calculus III
- 0 Research, Development, Testing, or Engineering
- 0 Applications Practicum (or equivalent experience)
- 1 Electronic Instrumentation: Calibration, Measurement, and Control
- 1 Technical Communications in Written and Oral Reports
- 0 Human Relations, Personal Relations, or alternative course
- 1 Chemical Sampling and Analysis
- 0 Technical or Applied Science Elective
- 0 Research, Development, Testing, or Engineering Applications
- 0 Practicum (or equivalen experience)

3. Years: 14, 10, 11, 8, 4, 3, 11, 10, 8, 2, 10 1/2, 1/2, 2 full and 4 part.

4.
- 1 English Composition I and II
- 1 Introduction to Literature and various literature courses
- 1 Remedial English
- 1 Manufacturing Processing I
- 1 Manufacturing Processing II
- 2 Strength of Materials
- 1 Mechanical Dynamics Technology
- 1 Engineering Theromodynamics
- 1 Materials and Metalurgy
- 1 Numerical Control Programing
- 1 Hydrauligest Programatics
- 1 Engineering Mechanics I
- 1 Engineering Mechanics II
- 1 Statistics and Dynamics
- 2 Basic Drafting
- 1 Descriptive Geometry
- 1 Engineering Materials
- 1 Blueprint Reading
- 2 Electrical Circuits I
- 1 Electrical Circuits II
- 2 Electronics I
- 1 Electronics II
- 1 Computer Programming
- 1 Digital Logic
- 1 Instrumentation
- 1 Essential Math
- 1 Basic Math I
- 1 Basic Math II
- 1 College Algebra
- 1 Introduction to College Math
- 1 Allied Health Math
- 1 Calculus I
- 1 Calculus II
- 1 Linear Math
- 1 Lineary Math
- 3 Most all Math
- 2 Physics

1	Vocational and Technical	1	Physical Geography
1	Electronic Math	1	Historical Geography
1	DC Circuits	1	Manufacturing Process
1	AC Circuits	1	Materials
1	Drawing	1	Machine Shop
1	Electronics Fabrications	1	Chemistry
1	Technical Math I	1	Chemical Technology I
1	Technical Math II	1	Chemical Technology II
1	Technical Geometry and Calculus	1	Industrial Arts

5.

1	English	2	Dental Lab Technician
1	Mechanical Engineering Technology	2	Electronics
1	First two years - Engineering Science Transfer	1	Business Administration
		1	Data Processing Technician
1	Architectural Drafting Technology	2	Electrical
1	Mechanical Drafting Technology	1	Civil Engineering Technology
1	Building Construction Technology	1	College Transfer
2	Industrial Electronic Technology	1	Machinist
4	Electronic Engineering Technology	1	Chemical Technology
1	Resperatory Therapy	1	Associate of Applied Science
2	Opticianary		

6.

	Have Used	Have Not Used	Comparison Mean
a.	1	4	5
b.	1	4	5
c.	1	4	5
d.	2	4	3
e.	2	3	3.7
f.	0	4	2
g.	2	3	3
h.	1	3	5
i.	1	3	5
j.	1	3	4.3
k.	1	3	4
l.	1	3	4
m.	0	3	

7.

	Comparison Mean
a.	3.1
b.	3.5
c.	3.3
d.	3.2
e.	3.4
f.	3.6
g.	3.6
h.	3.5
i.	3.5
j.	4.0
k.	3.2

	Comparison Mean
l.	3.7
m.	4.1
n.	4.2
o.	2.8
p.	3.3

8.

	Comparison Mean
a.	2.0
b.	3.0
c.	1.9
d.	2.5
e.	3.0

9. a. 2 BA/BS
   9 MA/MS
   1 PhD/ScD
   1 Other (EdD)

   b. 5 Sciences
   6 Engineering
   0 Social Sciences
   1 Humanties

10. 13 Male
    1 Female

11. Interdisciplinary
    Study materials strengthen lectures and demonstrations
    Hand-on experience is good
    The SET Work Books are good
    Chance to teach algebra and triganometry application
    Application of math to practical situations
    It meets the needs of industrial and research labor
    The practical curriculum
    The students have a specific goal
    Study Guide organization
    Prepares students to a technical education
    Program's approach to the technical materials.

12. Broad range of student population
    Our area didn't have adequate students
    Population to small for proper discussability
    Draggers we encountered
    Claims about transfer potential exxagerated
    Students don't see indepth discipline
    Too brief
    Lack of tests
    The cirriculum
    Needs more exposure to public and industry

If the concept could be implemented and followed through to its conclusion, students should perform satisfactorily
Keep SET courses separate from traditional technology courses